STRIPED DOLPHIN (*Stenella coeruleoalba*):
Hawaii Stock

STOCK DEFINITION AND GEOGRAPHIC RANGE

Striped dolphins are found in tropical to warm-temperate waters throughout the world (Perrin *et al*. 2009). Sightings have historically been infrequent in shallow waters (Shallenberger 1981, Mobley *et al*. 2000), though they are common, even in nearshore waters greater than 3500m (Baird 2016). Summer/fall shipboard surveys of the waters within the U.S. Exclusive Economic Zone (EEZ) of the Hawaiian Islands, resulted in 15 sightings of striped dolphins in 2002. 29 in 2010, and 27 in 2017 (Figure 1; Barlow 2006, Bradford *et al*. 2017, Yano *et al*. 2018).

Striped dolphins have been intensively exploited in the western North Pacific, where three migratory stocks are provisionally recognized (Kishiro and Kasuya 1993). In the eastern tropical Pacific all striped dolphins are provisionally considered to belong to a single stock (Dizon *et al*. 1994). There is insufficient data to examine finer stock structure within Hawaiian waters, though data available to date do not suggest island-associated populations for this species (Baird 2016).

For the Marine Mammal Protection Act (MMPA) stock assessment reports, striped dolphins within the Pacific U.S. EEZ are divided into two discrete, non-contiguous areas: 1) waters off California, Oregon and Washington, and 2) waters around Hawaii (this report), including animals found both within the Hawaiian Islands EEZ and in adjacent high seas waters. Because data on abundance, distribution, and human-caused impacts are largely lacking for high seas waters, the status of the Hawaii stock is evaluated based on data from U.S. EEZ waters of the Hawaiian Islands (NMFS 2005). Striped dolphins involved in eastern tropical Pacific tuna purse-seine fisheries are managed separately under the MMPA.
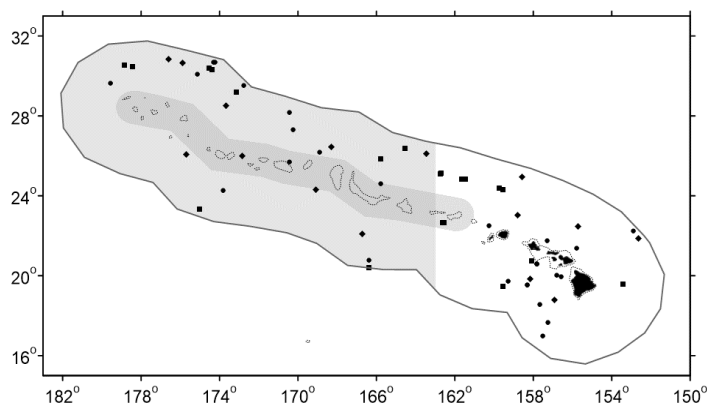

Figure 1. Striped dolphin sighting locations during the 2002 (diamonds), 2010 (circles), and 2017 (squares) shipboard surveys of U.S. EEZ waters surrounding the Hawaiian Islands (Barlow 2006, Bradford *et al*. 2017, Yano *et al*. 2018). Outer line represents approximate boundary of survey area and U.S. EEZ. Dark gray shading indicates the original Papahanaumokuakea Marine National Monument, with the lighter gray shading denoting the full 2016 Expansion area. Dotted line represents the 1000 m isobath.

POPULATION SIZE

Encounter data from shipboard line-transect surveys of the entire Hawaiian Islands EEZ was recently reevaluated, resulting in model-based abundance estimates of striped dolphins in the Hawaii EEZ (Becker *et al*. 2021; Table 1).

Table 1. Line-transect abundance estimates for striped dolphins derived from surveys of the entire Hawaii EEZ in 2002, 2010, and 2017 (Becker *et al*. 2021).

Year	Model-based abundance	CV	95% Confidence Limits
2017	35,179	0.23	22,416-55,209
2010	36,886	0.22	24,004-56,681
2002	35,817	0.22	23,384-54,861

Sighting data from 2002 to 2017 within the Hawaii EEZ were used to derive habitat-based models of animal density for the overall period. The models were then used to predict density and abundance for each survey year based on the environmental conditions within that year (see Forney *et al*. 2015, Becker *et al*. 2016). The modeling framework

incorporated Beaufort-specific trackline detection probabilities for striped dolphins from Barlow *et al*. (2015). Bradford *et al*. (2021) produced design-based abundance estimates for striped dolphins for each survey year that can be used as a point of comparison to the model-based estimates. While on average the estimates are similar between the two approaches, the annual design-based estimates show much greater interannual variability than the model-based estimates (Figure 2). The model-based approach reduces variability through explicit examination of habitat relationships across the full dataset, while the design-based approach evaluates encounter data for each year separately and thus is more susceptible to the effects of encounter rate variation. Model based-estimates are based on the implicit assumption that changes in abundance are attributed to environmental variability alone. There are insufficient data to explicitly incorporate a trend term into the model due to the insufficient sample size to test for temporal effects. Despite not fully accounting for inter-annual variation in total abundance, the model-based estimates are considered the best available estimate for each survey year. Previously published design-based estimates for the Hawaii EEZ from 2002 and 2010 surveys (e.g. Barlow 2006, Bradford *et al*. 2017) used a subset of the dataset used by Becker *et al*. (2021) and Bradford *et al*. (2021) to derive line-transect parameters, such that these estimates have been

Figure 2. Comparison of design-based (circles, Bradford *et al*. 2021) and model-based (triangles, Becker *et al*. 2021) estimates of abundance for striped dolphins for each survey year (2002, 2010, 2017).

superseded by the estimates presented here. The best estimate of abundance is based on the 2017 survey, or 35,179 (CV=0.23).

Population estimates are available for Japanese waters (Miyashita 1993) and the eastern tropical Pacific (Wade and Gerrodette 1993), but it is not known whether any of these animals are part of the same population that occurs around the Hawaiian Islands.

Minimum Population Estimate

The minimum population size is calculated as the lower 20th percentile of the log-normal distribution (Barlow *et al*. 1995) of the 2017 abundance estimate, or 29,058 striped dolphins.

Current Population Trend

The model-based abundance estimates for striped dolphins provided by Becker *et al.* (2021) do not explicitly allow for examination of population trend other than that driven by environmental factors. Model-based examination of striped dolphin population trends including sighting data beyond the Hawaii EEZ will be required to more fully examine trend for this stock.

CURRENT AND MAXIMUM NET PRODUCTIVITY RATES

No data are available on current or maximum net productivity rate.

POTENTIAL BIOLOGICAL REMOVAL

The potential biological removal (PBR) level for the Hawaii stock of striped dolphins is calculated as the minimum population size within the U.S. EEZ of the Hawaiian Islands (29,058) <u>times</u> one half the default maximum net growth rate for cetaceans (½ of 4%) <u>times</u> a recovery factor of 0.5 (for a stock of unknown status with no known fishery mortality and serious injury within the Hawaiian Islands EEZ; Wade and Angliss 1997), resulting in a PBR of 291 striped dolphins per year.
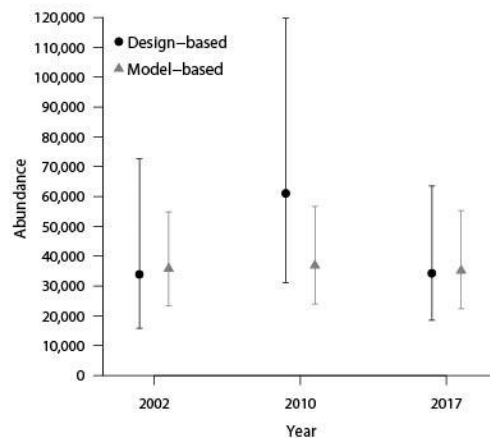
HUMAN-CAUSED MORTALITY AND SERIOUS INJURY

Fishery Information

Information on fishery-related mortality and serious injury of cetaceans in Hawaiian waters is limited, but the gear types used in Hawaiian fisheries are responsible for marine mammal mortality and serious injury in other fisheries throughout U.S. waters. Entanglement in gillnets and hooking or entanglement in various hook and line fisheries have been reported for small cetaceans in Hawaii (Nitta & Henderson, 1993). No estimates of human-caused mortality or serious injury are currently available for nearshore hook and line or gillnet fisheries because these fisheries are not

Figure 3. Locations of striped dolphin takes in Hawaii-based longline fisheries, 2014-2018. Solid lines represent the U.S. EEZs. Gray shading notes areas closed to longline fishing.

observed or monitored for protected species bycatch. There are currently two distinct longline fisheries based in Hawaii: a deep-set longline (DSLL) fishery that targets primarily tunas, and a shallow-set longline fishery (SSLL) that targets swordfish. Both fisheries operate within U.S. waters and on the high seas. Between 2014 and 2018, two striped dolphins were seriously injured, one not seriously injured, and one could not be determined based on the information provided by the observer in the SSLL fishery (100% observer coverage), and one striped dolphin was seriously injured in the DSLL fishery (18-21% observer coverage) (Figure 3, Bradford 2018a, 2018b, 2020, Bradford and Forney 2017, McCracken 2019). All striped dolphin interactions occurred outside of the U.S. EEZs. Average 5-yr estimates of annual mortality and serious injury for 2014-2018 are 0.4 (CV = 1.0) dolphins outside of U.S. EEZs, and zero within the Hawaiian Islands EEZ (Table 2). Three additional unidentified cetaceans were taken in the DSLL fishery, some of which may have been striped dolphins.
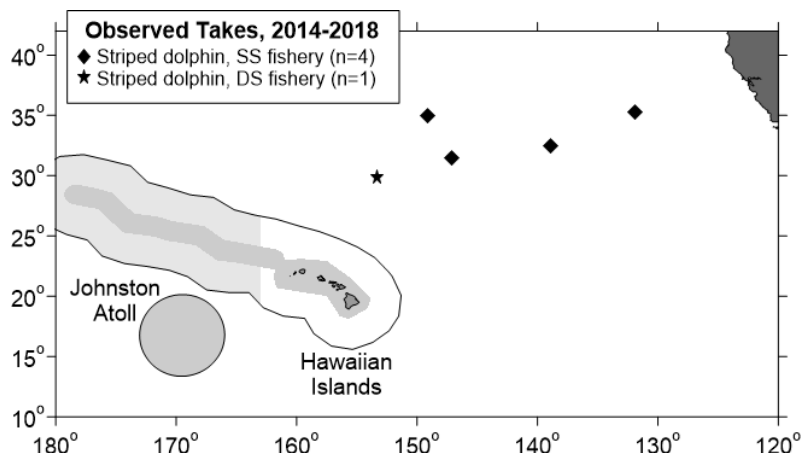
Table 2. Summary of available information on incidental mortality and serious injury of striped dolphin (Hawaii stock) in commercial longline fisheries, within and outside of U.S. EEZs (McCracken 2019). Mean annual takes are based on 2014-2018 data unless otherwise indicated. Information on all observed takes (T) and combined mortality events & serious injuries (MSI) is included. Total takes were prorated to deaths, serious injuries, and non-serious injuries based on the observed proportions of each outcome.

Fishery Name	Year	Data Type	Percent Observer Coverage	Observed total interactions (T) and mortality events, and serious injuries (MSI), and total estimated mortality and serious injury (M&SI) of striped dolphins			
				Outside U.S. EEZs		Hawaiian EEZ	
				Obs. T/MSI	Estimated M&SI (CV)	Obs. T/MSI	Estimated M&SI (CV)
Hawaii-based deep-set longline fishery	2014	Observer data	21%	0	0 (-)	0	0 (-)
	2015		21%	1/0	3 (1.1)	0	0 (-)
	2016		20%	0	0 (-)	0	0 (-)
	2017		20%	0	0 (-)	0	0 (-)
	2018		18%	0	0 (-)	0	0 (-)
Mean Estimated Annual Take (CV)					**0.4 (1.0)**		**0 (-)**
Hawaii-based shallow-set longline fishery	2014	Observer data	100%	2/2[†]	2	0	0
	2015		100%	0	0	0	0
	2016		100%	1/1	2	0	0
	2017		100%	1/0	1	0	0
	2018		100%	0	0	0	0
Mean Annual Takes (100% coverage)					**0.5**		**0**
Minimum total annual takes within U.S. EEZ							**0 (-)**

[†] Injury status could not be determined based on information collected by the observer. Injury status is prorated (see text).

STATUS OF STOCK

The Hawaii stock of striped dolphins is not considered strategic under the 1994 amendments to the MMPA. The status of striped dolphins in Hawaiian waters relative to OSP is unknown, and there are insufficient data to evaluate trends in abundance. Striped dolphins are not listed as "threatened" or "endangered" under the Endangered Species Act (1973), nor designated as "depleted" under the MMPA. Given the absence of recent recorded fishery-related mortality or serious injuries in U.S. EEZ waters, total fishery mortality and serious injury for striped dolphins can be considered insignificant and approaching zero. One striped dolphin stranded in the main Hawaiian Islands tested positive for *Brucella* (Chernov 2010) and two for *Morbillivirus* (Jacob *et al*. 2016). *Brucella* is a bacterial infection that if common in the population may limit recruitment by compromising male and female reproductive systems, and can also cause neurological disorders that may result in death (Van Bressem *et al*. 2009). Although *morbillivus* is known to trigger lethal disease in cetaceans (Van Bressem *et al*. 2009), its impact on the health of the stranded animals is not known as it was found in only a one tested tissue within each animal (Jacob *et al*. 2016). The presence of *Morbillivirus* in 10 species (Jacob *et al*. 2016) and *Brucella* in 3 species (Cherbov 2010, West unpublished data) raises concerns about the history and prevalence of these diseases in Hawaii and the potential population impacts on Hawaiian cetaceans. It is not known if *Brucella* or *Morbillivirus* are common in the Hawaii stock.

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